Exposure to and experience of self-harm and self-harm related content: An exploratory network analysis

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Funding:

OJK is supported by a postdoctoral fellowship from an FWO Odysseus grant to Prof. Inez Myin-Germeys, KU Leuven (FWO GOF8416N). Funding provided to IH by Ghent University postdoctoral fellowship 01P05517. LM received funding for this study from the Richard Benjamin Trust (as part of a wider programme of work).

Author note: This manuscript is in press at *Psychiatry Research*. Please cite as: Kirtley, O. J., Hussey, I., & Marzano, L. (In press). Exposure to and experience of self-harm and self-harm related content: An exploratory network analysis. *Psychiatry Research.* doi:10.31234/osf.io/gyhzr

Abstract

Exposure to the self-harm behaviour of others plays a role in individuals' own self-harm thoughts and behaviours, but there has been little consideration of the broader range of mediums through which exposure to self-harm related content may occur. N = 477 participants completed an online study, including questions regarding lifetime history of self-harm thoughts and behaviours and the frequency with which they had been exposed to self-harm via various mediums. Gaussian Markov random field network models were estimated using graphical LASSO and extended Bayesian information criterion. Bootstrapping revealed that exposure mediums with a direct connection to self-harm thoughts and behaviours were the internet (r_{rp} = .34, 95% CI [.26, .42]) and in-passing 'miscellaneous' exposure (r_{rp} = .14, 95% CI [.00, .23]). However, stability of the network centrality was low (expected influence stability = 0.52). The node with the greatest increase in expected influence within the network was miscellaneous "in-passing" exposure. In-passing exposure is an understudied exposure medium. Our results may suggest new types of exposure mediums for future research. Data were cross-sectional, so temporal relationships between exposure and behaviour could not be determined. Low stability of the networks suggests that future similar studies would benefit from larger sample sizes.

Keywords: Self-harm, exposure, network analysis

Highlights

- Study examined wide variety of types of exposure to self-harm and related content
- First ever network analysis of diverse range of exposure mediums
- In-passing and online exposure directly associated with self-harm thoughts and behaviours
- Future research should investigate temporal dynamics of different exposure mediums

Introduction

A key vulnerability factor for self-harm, defined as self-poisoning or self-injury irrespective of suicidal intent (NICE, 2004; 2011), is exposure to others' self-harm behaviour. Being exposed has been associated with individuals' own self-harm behaviours (McMahon, Corcoran, Keeley, Perry, & Arensman, 2013; Muehlenkamp, Hoff, Licht, Azure, & Hasenzahl, 2008; O'Connor, Rasmussen, & Hawton, 2014), non-suicidal self-injury (NSSI) behaviours (Muehlenkamp, Hoff, Licht, Azure, & Hasenzahl, 2008; Zhu et al., 2016), suicidal thoughts and behaviours (Wetherall et al., 2018) and suicide attempts (Chan et al., 2018; Kimbrel et al., 2016; Mars et al., 2014; Mars et al., 2019). Exposure to suicide attempts and deaths via friends and family is not uncommon and estimates from a meta-analysis suggest that approximately 22% of individuals have been exposed to suicide via friends and/or family at some point within their lifetime (Andriessen, Rahman, Draper, Dudley, & Mitchell, 2017).

Understandably, exposure to self-harm among individuals' direct social network has been the subject of much research attention, as has the impact of media reports of suicidal behaviour (Marzano, Fraser, Scally, Farley, & Hawton, 2018; Sisask & Värnik, 2012). However, exposure to self-harm can occur through a variety of mediums, including the internet, film and TV, peripheral social networks, and individuals' work or education. Exposure to self-harm via the internet has also received increasing amounts of attention within the research literature (Marchant et al., 2017).

The role of social media and the internet in the development and maintenance of self-harm thoughts and behaviours, as well as wellbeing and mental health more broadly, has received significant and growing media attention in recent years. This is despite the dearth of high quality evidence supporting a direct link between digital technology use and poor psychological wellbeing (Orben & Przybylski, 2019a; Orben & Przybylski, 2019b). More

recent high-quality studies employing sophisticated statistical techniques have found effect sizes of the relationship between digital technology use and reduced wellbeing to be very small, i.e. not explaining more than 0.4% of the variance (Orben & Przybylski, 2019a) and effect sizes for negative effects of social media on wellbeing to be "trivial" (Orben, Dienlin, & Przybylski, 2019). Estimates suggest that around 23% of young people have been exposed to self-harm and suicide-related content online (Mars et al., 2015). Results regarding exposure to self-harm content online and individuals' own self-harm behaviours are mixed. A large systematic review of the relationship between internet use and self-harm in young people found that some studies reported deleterious relationships (mainly between internet addiction and self-harm) and others reported positive outcomes, such as help-seeking for self-harm (Marchant et al., 2017). Similarly, self-harm and suicide-related internet use was correlated with having engaged in self-harm with suicidal intent, however, a high number of participants also reported having accessed support and help resources online (Mars et al., 2015). Exposure to suicide-related content by "stumbling" upon content on the internet was reported by young people in a recent qualitative study (Biddle, Derges, Goldsmith, Donovan, & Gunnell, 2018), but this type of incidental exposure has mostly been overlooked in previous research.

Exposure through films and TV has received comparatively less attention. One study investigating the effect of exposure to self-harm related content via films found that this type of exposure was significantly associated with individuals having a history of engaging in NSSI (Radovic & Hasking, 2013). More recently, the release of US television series "13 Reasons Why" provoked widespread controversy because of its graphic depiction of suicide, with some studies indicating a relationship between the release of the series and increased suicide attempts (Niederkrotenthaler et al., 2019) and internet searches for suicide-related content (Ayers, Althouse, Leas, Dredze, & Allem, 2017).

Recent figures indicate that non-suicidal self-harm behaviours are rising, especially among women and girls (McManus et al., 2019), therefore there is a pressing need to better understand the correlates of these behaviours, in order to inform treatment and intervention development, especially as the rise in self-harm does not correlate with a rise in mental health service contact (McManus et al., 2019). Given that exposure has been consistently associated with engagement in suicidal and non-suicidal self-harm, this represents an important phenomenon to investigate. Previous studies of exposure have only examined a limited array of exposure mediums, such as having a friend or family member who has engaged in suicidal or non-suicidal self-harm, or exposure via the internet or films. We know little about the relationship between other types of exposure, e.g. incidental in-passing observation, and individuals' own self-harm thoughts and behaviours. Furthermore, there has been little investigation of whether some of these types of exposure are more strongly associated with self-harm thoughts and behaviours than others are or how different types of exposure may relate to one another. If specific targets for self-harm prevention initiatives are to be identified, a broader and more nuanced approach to investigating the role of exposure in self-harm thoughts and behaviours is needed.

In the current exploratory study, we sought to investigate the relationship between exposure to self-harm and self-harm related content, and individuals' own self-harm thoughts and behaviours, using a network analysis approach applied to pre-existing online survey data.

Method

Participants and procedure

A community sample of adults ($N = 506$) completed a battery of anonymous online questionnaires assessing self-harm thoughts and behaviours, and experiences of exposure to self-harm behaviour and non-suicidal self-harm related content. This study used pre-existing

data from a larger study exploring public attitudes towards self-harm. Fifteen individuals provided no data at all and consequently were excluded. A further 14 participants were excluded because they were below the age at which they were permitted to participate in the study (17 years old +), but had proceeded through the age warning. Our final sample thus comprised 477 participants (M_{age} = 25.41, SD = 9.46). The majority of the sample were female (81.8%), 13.6% were male, 1.7% identified as transgender/non-binary, and 2.9% did not report their gender identity. From the total sample, (n = 109) individuals reported no history of self-harm thoughts or behaviours.

Participants were recruited via the participant pools at two large UK universities, as well as by social media and online study advertisement pages. The wording of recruitment adverts did not specifically target individuals with self-harm thoughts or behaviours, however it did state the aim of the study as being to "explore public experiences, attitudes and beliefs about potentially harmful behaviours, including self-inflicted ones." It also stated that the study included potentially sensitive questions in relation to direct and indirect experiences of self-harm. The study received ethical approval from the Middlesex University Psychology Department ethics committee (Reference number ST002-2014) and the University of Glasgow College of Medicine and Veterinary Sciences Ethics Committee (Reference number 200140072). Individuals were invited to take part in an online study about their beliefs and experiences around self-harm, which took approximately 20 minutes to complete. All who took part in the study were given the option of being entered into a prize draw to win a £25 gift voucher. On each page of the study questionnaire site, participants could access a support sheet with contact information for various national and international support organisations (e.g. Samaritans) in the event that they experienced distress during completion of the questionnaires.

Measures

Demographics. Data regarding participants' age, ethnicity, gender identity, and employment status were collected.

Exposure to self-harm. 11-items, most of which were adapted from the Level of Contact Report (LCR; Corrigan, Green, Lundin, Kubiak, & Penn, 2001; Holmes, Corrigan, Williams, Canar, & Kubiak, 1999), were used to assess participants' exposure to self-harm and related content, where self-harm was defined for participants as "harmful self-inflicted behaviours (e.g., cutting, swallowing dangerous substances, burning skin with matches or cigarettes), seemingly carried out without suicidal intent." Participants were explicitly informed that "socially sanctioned behaviours, such as smoking or tattoos, [were] not included in this definition." Questions regarding exposure to self-harm and self-harm related content therefore referred to non-suicidal self-harm, however, we also asked about exposure to suicide attempts and suicide death. Consequently, we use the term 'self-harm' as suicidal and non-suicidal self-harm exposures were captured within the questionnaire. Exposure to self-harm in seven different areas of life were assessed. This included personal experience of knowing an individual (friend, family or acquaintance) who has engaged in self-harm ('others'), or experience via movies or TV shows ('movies'), in the context of their job ('job'), through working or studying with someone who self-harms ('work/study'), through training specifically related to self-harm thoughts or behaviours ('training'), or through the internet ('internet'). We also included a seventh category ('miscellaneous') that covered in-passing, incidental exposure to others' self-harm (e.g., observing, in passing, someone who participants thought may have self-harmed). Responses regarding exposure via movies/TV, internet, training, and working/studying with someone who self-harms were given on a four-point Likert-type scale ranging from 0 (never) to 3 (often). Questions regarding knowing someone who engaged in self-harm or attempted suicide, having friends or family who have

self-harmed or have attempted suicide, or who have died by suicide were ‘yes/no’ responses. Two items within the questionnaire were ‘branched’, i.e. conditional upon answers to two ‘gate’ questions. Participants were first asked if they knew someone who had attempted suicide. Only if they answered ‘yes’ were they given presented with a follow-up question regarding whether they had a close friend or family member who had attempted suicide. This was also the case for the question regarding whether participants knew someone who had died by suicide. As the branched questions regarding friends and family were conditional upon the gate questions and therefore not independent from the gate questions, including them in the network analysis was not possible. Consequently, only the gate questions were included as variables within the analysis and were collapsed to form a single variable, which captured having a friend or a relative who self-harmed. The variable ‘others’ therefore represents exposure to self-harm, suicide attempt or suicide death of someone they know (including friends or family members), and was computed from three items on the questionnaire. Following data collection, we noticed that one item from the questionnaire “I have frequently observed persons who self-harm”, was conceptually incongruent with the response scale, which asked about frequency of the exposure. We therefore excluded this item from the analyses.

The original scoring of the LCR involved assigning scores based on the item they had endorsed with the highest proximity or intimacy (previously ranked by expert reviewers). For the purposes of our research question, we instead employed responses on each item (i.e., exposure type) as sum scores calculated across the items (for the purposes of the regression analysis) or as separate variables (for the network analysis).

History of self-harm. Participants’ own experiences of having self-harm thoughts and engaging in self-harm behaviours were assessed using three additional items. These items asked participants three questions regarding whether or not they had (a) experienced thoughts

of non-suicidal self-harm, (b) had engaged in non-suicidal self-harm behaviours, or (c) had made a suicide attempt. For each of these three items, responses were provided on a four-point Likert scale ranging from 0 (never) to 3 (often). Responses to each item were then dichotomised into 'absent' or 'present', with zero scores being categorised as indicating absence of the respective thoughts or behaviours and scores above zero categorised as indicating presence of the respective thoughts or behaviours. These three dichotomised variables were then used to calculate a self-harm thoughts and behaviours score (from 0 to 3), based on the most severe form of self-harm thoughts and/or behaviours that they reported having a history of. We conceptualized self-harm thoughts and behaviours as a spectrum (from non-suicidal self-harm thoughts, to non-suicidal self-harm behaviours, and finally to suicide attempts) and therefore wished to employ it as a continuous variable in our subsequent analyses.

In order to assess the appropriateness of this, we tested the assumption of whether our three dichotomous responses could be said to assess an underlying continuous latent variable. This was quantified using two effect size metrics. The first involved arranging the dichotomous variables in order of what we considered to be increasing severity (i.e., thoughts about non-suicidal self-harm < non-suicidal self-harm behaviours < suicide attempts). Then the proportion of participants who demonstrated violations of the expected relationships among these (e.g., unexpected combinations, such as participants who reported a history of non-suicidal self-harm behaviours but in the absence of any lifetime thoughts about non-suicidal self-harm) were calculated. This proportion is referred to as the Guttman Error Rate (*G*) and represents an intuitive effect size metric that is used within Item Response Theory modelling (e.g., Meijer, 1994). The second effect size normalizes the Guttman Error Rate by the number of items being tested, in order to produce a metric that is comparable between different analyses (i.e., *G**). Both metrics were bootstrapped via case removal for robustness.

Results demonstrated that the proportion of participants that violated the assumption that self-harm thoughts and behaviours could be treated as a continuous variable was very low, G = 0.031, 95% CI [0.017, 0.046], G^* = 0.010, 95% CI [0.006, 0.016]. This supported our conceptualization and data processing strategy, and enabled subsequent analyses. The final coding of the self-harm thoughts and behaviours variable was therefore as follows: no lifetime history of self-harm thoughts or behaviours (0); lifetime thoughts of non-suicidal self-harm (1); lifetime non-suicidal self-harm behaviours (2); and lifetime suicide attempt (3). The number of participants endorsing each type of self-harm thoughts or behaviour was: no lifetime history of self-harm thoughts or behaviours = 109, lifetime thoughts of non-suicidal self-harm = 64, lifetime non-suicidal self-harm behaviours = 135, and lifetime suicide attempt = 169).

Network analysis

All data were processed and analysed in R version 3.6.2 (R Core Team, 2019). The main packages used for the analyses were *qgraph* version 1.6.5 (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012) and *bootnet* version 1.4 (Epskamp, Borsboom, & Fried, 2018).

It is useful to first briefly describe network analysis as a general data analytic approach. Network analyses represent a class of statistics that deal with multivariate correlation and covariance networks. Whereas traditional regression approaches tend to employ a static threshold value for decision-making (e.g. $p < .05$), this would be problematic in the context of network analyses given the very high number of multiple comparisons being made. In order to overcome this, evidence for associations between variables is determined via adaptive thresholding (i.e., graphical LASSO and selection via extended Bayesian

Information Criterion). For in-depth discussion of this approach, see Epskamp and Fried (2018).

We included self-harm thoughts and behaviours along with the seven different exposure types (i.e., others [family, friends, or acquaintances], movies, job, work/study, relevant training, internet, and miscellaneous) in our network model. A regularized partial correlation network was estimated using Spearman correlations and with an additional threshold placed on the regularized network (i.e., bootnet's threshold argument was set to TRUE), due to an overly dense network being selected without this additional threshold.

Assessing network stability

Previous work has suggested that the reliability of the results from network analyses should be quantified by calculating tests of network stability (Epskamp's stability metric: Epskamp & Fried, 2018). These represent the proportion of the sample that can be removed while retaining correlations of $r > .7$ with the full sample in 95% of bootstrapped cases. This statistic can therefore range between 0 and 1 with higher results being preferable. We assessed the stability of a centrality metric that is designed to capture a node's role within the broader network (i.e., Expected Influence: Robinaugh, Millner, & McNally, 2016). This centrality metric has been argued to be more conceptually appropriate for use with the analysis of clinical data than other centrality metrics due to the importance of the directionality of effects in such settings. Bootstrapped confidence intervals around this estimate of centrality stability were done via case removal, following the recommendations of Epskamp and Fried (2018). In addition, the stability of both edge weights and the Expected Influence of individual nodes were also bootstrapped via the non-parametric method, following the recommendations of Epskamp and Fried (2018).

Open materials, code and data

This study was not pre-registered. All materials and code are available on the Open Science Framework (osf.io/u35mk). It is not possible to share the participant data due to the nature of informed consent obtained in the original study, however we have shared both the correlation matrix among the variables, and a synthetic dataset created using the *synthpop* package version 1.5.1 (Nowok, Raab, Snoke, & Dibben, 2019). Synthetic datasets contain none of the original data, but mimic the original data's distributions and covariance matrix. They can be used to verify that the code for the original analysis runs correctly, and will produce similar (but not identical) results. The synthetic dataset was screened for "replicated uniques", i.e. values from the real dataset that were replicated in the synthetic dataset by chance and any such values were removed (Nowak, Dibben, & Raab, 2017). As a result of this, sample size and analysis results may differ slightly between the real and synthetic data.

Missing and excluded data

Missing data were analysed using the BaylorEdPsych R package (Beaujean, 2012). Little's Missing Completely at Random test (MCAR: Little & Rubin, 2002) demonstrated no evidence of problematic missingness, $\chi^2(117) = 128.97$, $p = .21$. Forty-four values were missing across the dataset. Missing data were handled by using pairwise comparisons when estimating the network.

Results

Regression analysis

We first examined whether lifetime exposure to self-harm and non-suicidal self-harm related content (from any source) was associated with lifetime self-harm thoughts and behaviours. Self-harm thoughts and behaviours was entered as the dependent variable in a linear regression, and sum scores on the exposure items were entered as the independent

variable. To increase robustness, estimates were bootstrapped via the case removal and percentile method and median estimates are reported. Results demonstrated significant evidence that lifetime exposure was related to individuals' own self-harm thoughts and behaviours, $B = 0.11$, 95% CI [0.08, 0.14], $\beta = 0.36$, 95% CI [0.27, 0.45], $p < .001$, $R^2 = .13$.

Network analysis

The estimated network is illustrated in Figure 1. The upper panel illustrates the network layout using the Fruchterman-Reingold algorithm, and the lower panel illustrates the network using *N*th order associations with self-harm thoughts and behaviours (SHTBs). The following factors aid the interpretation of this network: each circle ('node') represents a variable, and each line between them ('edge') represents the regularized partial correlation (r_{rp}) between them (i.e., the association between the two variables after controlling for all other associations in the network). Solid type indicates the directionality of the association: solid lines represent positive associations whereas dashed lines represent negative associations. A line's thickness and opacity represents the absolute magnitude of the association (thicker lines represent strong associations). Finally, the physical arrangement of the nodes illustrates the directness of the connection between the variables. The presence of an edge (line) represents evidence for the presence of an association between nodes (variables). The absence of a line represents an absence of evidence for an association (rather than evidence of absence of any association (Epskamp & Fried, 2018). Plotting *N*th order associations within a network is a relatively new method of plotting network models, and is particularly suited to our analytic question where one variable is of particular interest.

Edge weights were bootstrapped via the non-parametric method, following the recommendations of Epskamp and Fried (2018). Results demonstrated evidence for a direct ('one hop') association between self-harm thoughts and behaviours and exposure via both

'internet' (r_{rp} = .34, 95% CI [.26, .42]) and in-passing 'miscellaneous' exposure (r_{rp} = .14, 95% CI [.00, .23]). Associations that were more indirect were also observed, including 'two hop' associations with 'work/study', 'job', and 'movies and TV'. These refer to situations where there is no evidence of a direct association with self-harm thoughts and behaviours, but there is evidence for a connection to self-harm thoughts and behaviours via a third node that both are connected to (i.e. an indirect relationship). A 'three hop' indirect association - which represents an association with self-harm thoughts and behaviours via two other nodes - was also found for the exposure type 'training'. All edge weights are reported in Figure 2.

Network stability

Network stability was calculated via bootstrapped using the case removal method. Results demonstrated poor node centrality stability (Expected Influence stability = .52). Estimates of the Expected Influence of each node were bootstrapped via the non-parametric method and are reported in Figure 2.

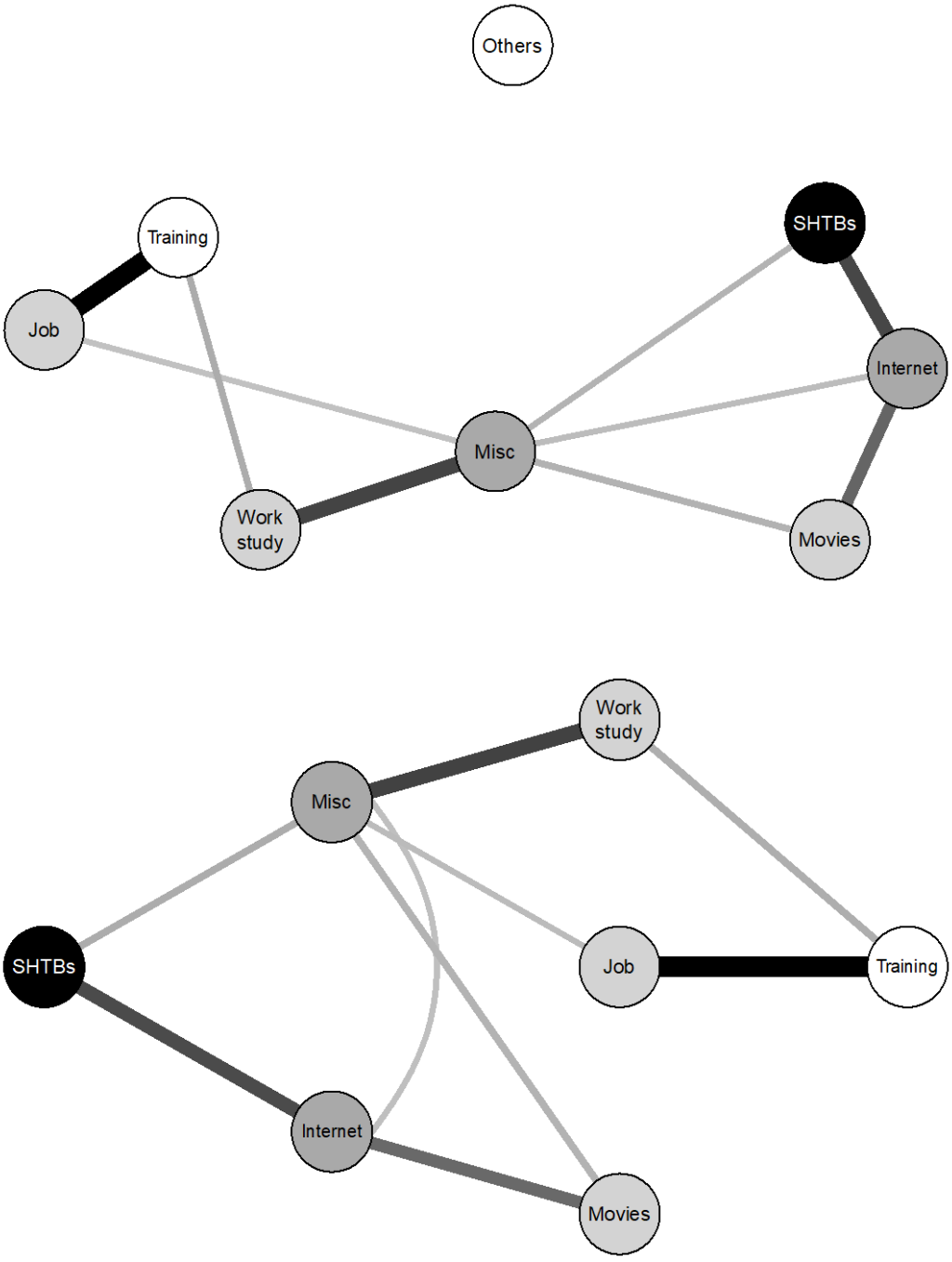

Figure 1. *Upper panel*: network layout using the Fruchterman-Reingold algorithm. Self-harm thoughts and behaviours are represented by the node, SHTBs. *Lower panel*: N^{th} order associations between self-harm thoughts and behaviours and different forms of exposure arranged from more to less direct (left to right). We have placed the variable of interest, self-harm thoughts and behaviours (SHTBs), on the far left. The node 'Others' was removed in this figure as it did not significantly relate to self-harm thoughts and behaviours, or any of the other exposure types.

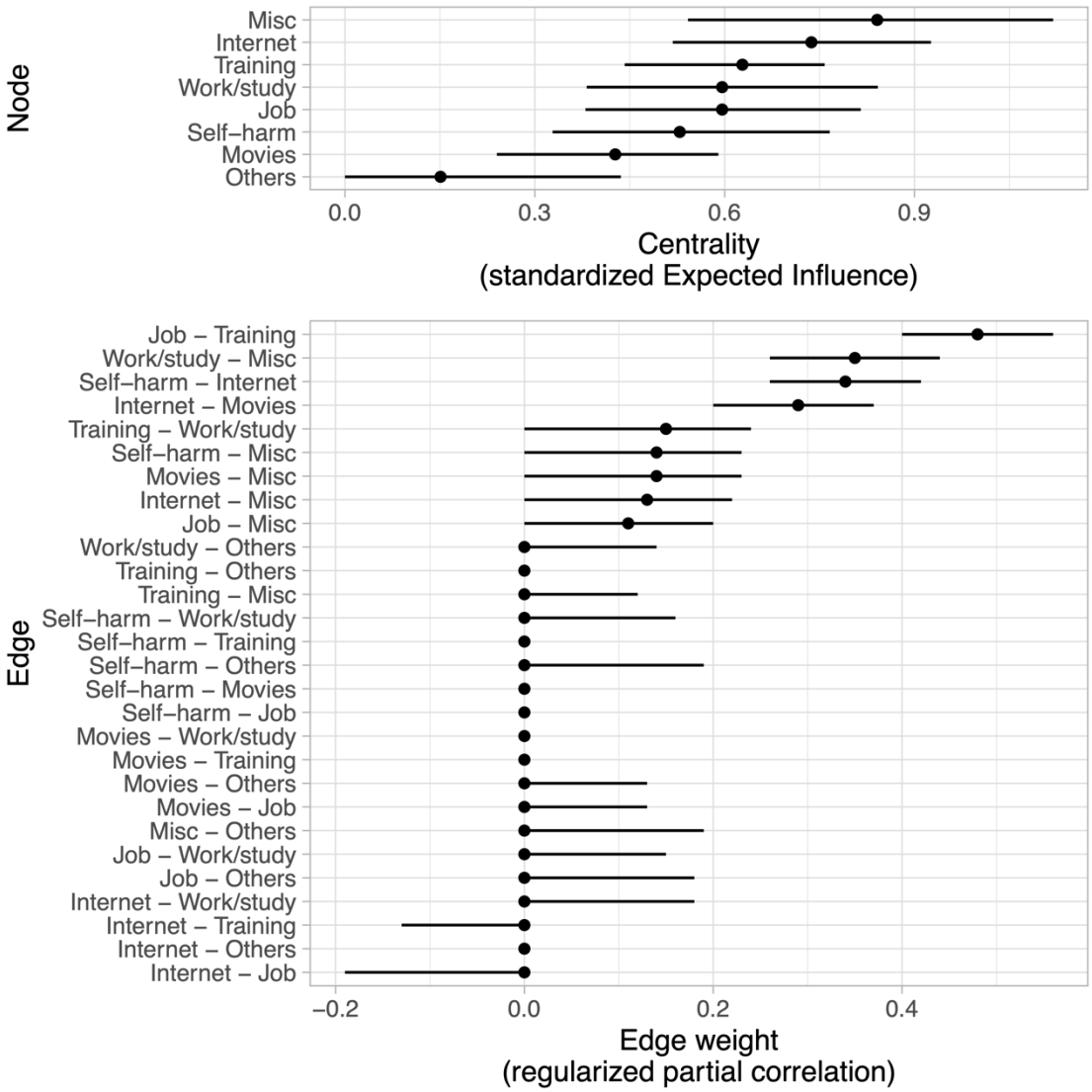

Figure 2. Estimates of node stability and edge weights. Points represent estimates and horizontal lines represent bootstrapped 95% CIs.

Discussion

Exposure across all types of self-harm and non-suicidal self-harm related content was related to individuals' own self-harm thoughts and behaviours. The results of the current network analysis show that the exposure variables that are most directly and strongly

associated with self-harm thoughts and behaviours are the internet and in-passing 'miscellaneous' exposure to non-suicidal self-harm related content. Working or studying with someone who engages in non-suicidal self-harm, experiencing non-suicidal self-harm during professional work or via movies/TV were all types of exposure with "two hop" associations with individuals' own history of self-harm thoughts and behaviours, indicating an indirect relationship with individuals' self-harm thoughts and behaviours. Similarly, exposure by undergoing training including non-suicidal self-harm related content also showed an indirect relationship to individuals' own self-harm thoughts and behaviours. Whilst the cross-sectional design of the current study means we cannot make inferences about the temporal ordering of exposure via different mediums or their causal relationships, future research should investigate the temporal relationship between different exposure mediums using longitudinal and micro-longitudinal designs. The Experience Sampling Method (ESM; Csikszentmihalyi & Larson, 1987), whereby individuals complete multiple brief questionnaires over multiple days whilst they are going about their everyday lives, may also provide opportunities for investigating the temporal dynamics of exposure to self-harm and related content in context. This would also enable the investigation of whether exposure through different mediums is a proximal predictor of self-harm thoughts or behaviours.

The absence of evidence for a relationship between exposure to self-harm via friends and family, and participants' own self-harm thoughts and behaviours, is surprising, given the strong association to individuals' own self-harm thoughts and behaviours found in previous studies (e.g. McMahon et al., 2013; Muehlenkamp et al., 2008; O'Connor et al., 2014; Wetherall et al., 2018; Zhu et al., 2016). Previous research has rarely investigated exposure to self-harm through friends and family alongside other exposure mediums, meaning the potential role of other types of exposure within this relationship has not been extensively examined. This finding should not be interpreted as evidence that exposure to self-harm via

friends and family does not relate to individuals' self-harm thoughts and behaviours, rather that we did not find evidence in support of an association between these two variables. As the network was estimated using partial correlations, they do not address the question of whether there are direct associations between variables, only whether there is unique association after controlling for other variables. Our study may also have been underpowered to detect such an association. The composite nature of the 'others' variable may also have produced different results relative to if we had included each type of exposure via others (exposure to non-suicidal self-harm behaviour, suicide attempts and suicide deaths) individually within the network (Hill et al., 2020) and we discuss this further in the limitations section.

Internet-related exposure to non-suicidal self-harm exhibited a strong and direct relationship to participants' self-harm thoughts and behaviours. A previous and extensive systematic review of research on online self-harm related content and self-harm thoughts and behaviours found results were highly heterogeneous and that the most pronounced effects appeared to be in studies of internet addiction and self-harm (Marchant et al., 2017). In the current study, we took frequency of exposure into account, but this does not speak to whether participants met criteria for problematic internet use. Furthermore, we did not separate out types of online content, e.g. social media, websites, videos or ask specifically about whether content was "positive" (e.g. support information) or "negative" (e.g. pro self-harm). Our results therefore may also reflect exposure to positive content that may encourage help-seeking or provide information about support options for non-suicidal self-harm.

The second variable to show a direct association with participants' self-harm thoughts and behaviours was "miscellaneous" exposure, i.e. incidental, in-passing observation of someone who participants thought may have engaged in non-suicidal self-harm. Whilst one recent qualitative study described young people who self-harm discussing "stumbling across" content and how this had negatively influenced their self-harm thoughts and behaviours

(Biddle et al., 2018), to our knowledge, no other studies have assessed this type of in-passing exposure to non-suicidal self-harm alongside other more well-known exposure mediums, such as through friends or family. Intuitively, being exposed to self-harm via an important figure in one's life, such as a friend or relative, would seem as though it should have a much greater impact on individuals' own self-harm thoughts and behaviours than observing someone in passing. Our results, however, indicate that frequent exposure to non-suicidal self-harm in-passing may be an important, but overlooked, factor relating to self-harm thoughts and behaviours. As such, in-passing exposure represents a potentially fruitful variable to investigate in future research.

The psychological processes underpinning the associations between exposure to self-harm and individuals' own self-harm thoughts and behaviours are not yet understood and this remains a key question for future studies in this area. The Cognitive-Emotional model of non-suicidal self-injury (Hasking, Whitlock, Voon & Rose, 2017) has been proposed as a framework for understanding how exposure to NSSI can influence individuals' own thoughts and behaviours. The Cognitive-Emotional model posits that individuals' expectancies about the outcome of behaviours influences the likelihood of behavioural engagement, as does the perceived self-efficacy to carry out the behaviour. Hasking and Rose (2016) suggest that those with more positive outcome expectancies (i.e. that NSSI will bring emotional relief) and less negative outcome expectancies (i.e. NSSI will not be painful) will be more likely to engage in NSSI. Empirical work to date has supported the validity of the model and has found that undergraduate students with more positive and less negative outcome expectancies were more likely to report NSSI (Hasking & Rose, 2016). More recently, Dawkins, Hasking, and Boyes (2019) found that individuals who were aware of their parents' NSSI had more positive and fewer negative outcome expectancies about NSSI and were more likely to report NSSI themselves. Dawkins and colleagues' (2019) study highlights outcome expectancies as

a key psychological process through which exposure to self-harm may influence individuals' own self-harm behaviours. Whilst outcome expectancies have specifically been investigated in the context of NSSI, they may also have relevance for self-harm irrespective of suicidal intent. Future research on exposure should incorporate measures of self-harm outcome expectancies to better understand the mechanisms through which exposure increases the likelihood of self-harm, or indeed decrease it.

Limitations

There are two important caveats regarding interpretation of the network analysis results from the current study. First, network analyses applied to cross-sectional data cannot speak to causality among the variables. This also cannot be inferred from the measures themselves: both measures of exposure and of self-harm thoughts and behaviours asked about lifetime incidence and prevalence rates, but not the relative timing of exposure and self-harm thoughts and behaviours (e.g., we did not ask about self-harm that occurred before vs. after exposures). This has important bearing on the current results: it may be the case that exposure to self-harm related content raises one's risk of self-harm thoughts or behaviours, or that individuals who engage in self-harm thoughts or behaviours seek out material related to these experiences in their lives, or the relationship may be bidirectional. Of course, in some types of exposure relative to others, one direction may be more likely than the other (e.g., seeking out content on the internet vs. accidentally seeing a stranger in public who may have engaged in non-suicidal self-harm), but this remains far from clear-cut. Future research is therefore necessary to understand the directionality of these relationships across contexts.

Second, it is important to correctly interpret the regularized partial correlations returned by network analyses. Take, for example, the "training" node, which showed only a third-order association with self-harm thoughts and behaviours. This does not mean that exposure to non-suicidal self-harm in the course of one's training is unassociated with self-

harm in an absolute sense, but that there is no evidence for its unique association with self-harm thoughts and behaviours after controlling for all other associations, and given our study's current sample and size. That is, absence of evidence for an edge between nodes should not be equated with evidence of absence of such an association. As such, it is important to interpret the results as follows: variables with first order associations are relatively stronger candidates for guiding future research and practice, whereas variables with higher order associations with self-harm thoughts and behaviours are relatively weaker candidates. The current study therefore seeks to provide positive evidence for the exposure variables that appear to be linked with self-harm, as opposed to negative evidence that rules out variables as being unrelated to it. As such, we do not wish to imply that any of these variables should be excluded from future research, but rather to guide researchers towards the more promising candidate sources of exposure.

A further consideration and one which should be carefully borne in mind for future research is that our measure of exposure to self-harm related content did not allow us to capture a particularly nuanced picture of exposure. For example, we asked participants about their exposure to non-suicidal self-harm online, but this did not allow participants to specify the type of content they had viewed (e.g. images or text) or whether they had specifically searched for the content or stumbled across it. Thus whilst our results suggest that there is a direct association between being exposed to non-suicidal self-harm content online and individuals' own self-harm thoughts and behaviours, we do not know whether specific types of online content are more pernicious than others. Additionally, we do not know whether individuals may have accessed supportive content online. The cross-sectional nature of the data precludes making inferences about the direction of these relationships or the degree of intentionality involved in exposure. It is therefore important for readers to keep in mind that

using the internet for positive, help-seeking purposes could have produced similar results to those we see here.

The composite nature of the 'others' variable may also have limited our analyses. A recent multilevel meta-analysis of the association between suicidal behaviour and exposure to suicide and suicidal behaviour (published whilst this paper was under review) highlighted that associations between exposure types and individuals' own suicidal behaviours are not uniform (Hill et al., 2020). Their results revealed that exposure to suicide was associated with increased odds of suicide and suicide attempt, whereas exposure to suicide attempt was associated with increased odds of suicide attempt only. The authors recommend that future studies of exposure should avoid composite variables including both exposure to suicide and suicide attempt (Hill et al., 2020). Whilst our IRT analysis supported operationalising our variable of interest – self-harm thoughts and behaviours- as continuous, ordered as non-suicidal self-harm thoughts > non-suicidal self-harm behaviours > suicide attempt, Hill et al's (2020) findings may indicate that associations between exposure to non-suicidal self-harm and related content may also not be uniform. Subsequent research on exposure should empirically investigate this. Some outcomes, e.g. suicidal behaviour, have been studied more in relation to exposure than others, e.g. suicidal ideation (Hill et al., 2020), thus substantive investigation of different types of outcomes of exposure may also be fruitful in future research.

An additional limitation of the current study is that other psychological variables of potential interest, e.g. depressive symptoms, life events, impulsivity etc., were not included. McMahon and colleagues (2013) have previously shown that individuals with and without exposure to the self-harm of friends and family also differ on other psychosocial variables. For example, adolescents who reported self-harm and had been exposed to self-harm via friends or family reported a greater number of negative life events, lower self-esteem and

higher impulsivity than adolescents who reported self-harm but had no exposure via friends or family (McMahon et al., 2013). Future studies of exposure to self-harm should also include measures of other relevant psychological variables to examine whether different exposure experiences are associated with different profiles of psychological risk and protective factors for self-harm thoughts and behaviours.

Conclusions

The results of the current exploratory network analysis show that in-passing and online exposure to non-suicidal self-harm related content has a direct relationship to individuals' own self-harm thoughts and behaviours. Surprisingly, there was no evidence that exposure to self-harm behaviours of others, e.g. friends and family, was uniquely associated with participants' own self-harm thoughts and behaviours (i.e., after controlling for other exposure types). Previous research may have underestimated the role of incidental, in-passing types of exposure to self-harm and this should be explored further in future research. Ideally, this should also incorporate cognitive-emotional factors to better understand the psychological processes through which exposure influences individuals' own self-harm thoughts and behaviours.

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